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Report No. 1800-84 ✓

# ~~Aerojet-General~~ CORPORATION

AZUSA, CALIFORNIA

## IN F O R M A L   R E P O R T   O F   P R O G R E S S

Copy No. 5

16 September 1953

TO: Office of Naval Research  
Department of the Navy  
Washington 25, D. C.

VIA: Bureau of Aeronautics Representative  
Aerojet-General Corporation  
6352 N. Irwindale  
Azusa, California

SUBJECT: Research, Development, and Testing  
of Underwater Propulsion Devices

CONTRACT: N6ori-10, Task Order I  
Project NR 097 003

PERIOD  
COVERED: 1 August through 31 August 1953

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This informal monthly progress report is  
submitted in partial fulfillment of the  
contract.

AEROJET-GENERAL CORPORATION

*C. A. Gongwer*  
C. A. Gongwer, Manager  
Underwater Engine Division

NOTE: The information contained herein is regarded as preliminary  
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Report No. L800-84

## I. TEST MOTORS USING 3.75-IN.-DIA GRAINS

### A. STANDARD MOTOR

Quality control of 3.75-in.-dia grains is being conducted as a continuous check on grain production and mix evaluation.

### B. SHORT-CHAMBER MOTOR

Check-out runs during this month have confirmed the turbulator configuration which gives chamber conditions similar to those desired for free-running hydroductor runs.

### C. HYDRODUCTOR

The hydroductor test stand has been reworked to permit easier interchange of components in order to facilitate future testing. In addition, a new vacuum recording system is being installed.

### D. SPECIAL RUNS

1. The series of runs to investigate starting sequence was continued, with attention focused on the igniter. More work will have to be done before any definite conclusions can be reached, but it seems that better adhesion between igniter cap and grain is indicated.

2. The effect of smoothing the outside of the grain, that is, the surface over which water flows, was investigated. The net effect is a reduction in pressure drop which will permit the free-running missile to operate at a slightly higher chamber pressure if necessary.

3. A total of 33 static runs were made during August.

## II. ALCLO-FIRED TEST STEAM GENERATOR FOR SUBMARINES

A. Except for the final report on this project this monthly report concludes the work to be done.

B. The steam generator has been operated in a closed gas cycle for a total of 30 minutes. Some difficulties were encountered in carrying the flame across the butted ends of the propellant grains, and this limited the longest train of grains burned at one time to 16, or approximately 4 minutes of firing.

C. The feeding mechanism operated satisfactorily.

D. The boiler is coated with powdery ash which does not appear to be detrimental to its operation as no abnormal temperatures were observed for the recirculating gas leaving the boiler.

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### III. ALCLO STUDIES

A. Twenty-one 3.75-in.-dia grains were produced during August. Ten five-increment grains were pressed for the hydroduct or hydroductor missiles. These grains averaged about 6.87 in. long and weighed approximately 7.5 lb each. Eleven standard six-increment grains were pressed. These grains averaged about 8.25 in. long and weighed approximately 9 lb each.

B. The lots of flake-type aluminum powder used in the preparation of Alclo show marked variations in their tendency toward laminary fracturing. The problem of correlating the factor or factors causing this variation has not been solved to date. By varying the "dwell" time (the most difficult powder to press requiring 3 min at 20,000 psi and 3 min at 45,000 psi), grains which are free of laminary fractures can be obtained.

### IV. GASOLINE-AIR HYDROPULSE

A. The new cam-actuating system for the air-control valve has been installed and tested. Valve action has been improved, as desired, to give rapid opening, and practically instantaneous closing.

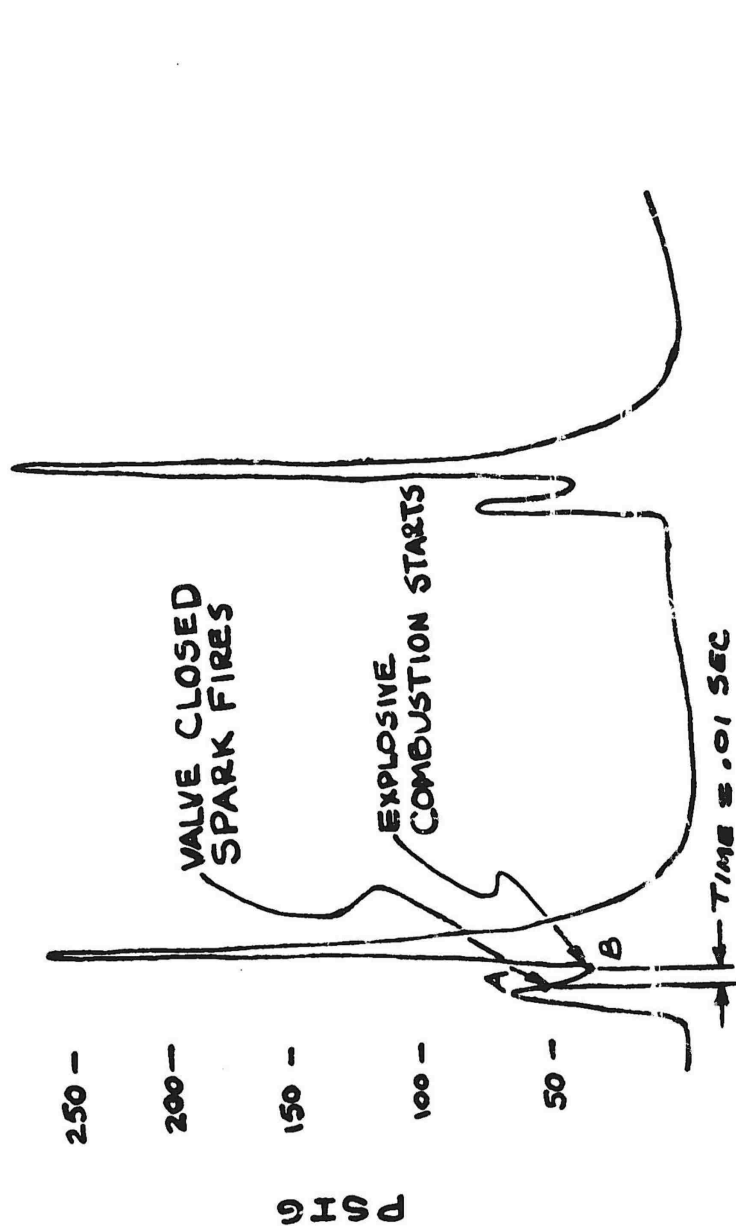
B. With the spark set to fire exactly at the instant the valve seats, steady, consistent operation of the motor is obtainable. However, the combustion is apparently delayed for an instant, thus permitting the precompressed charge to expand partially before the combustion pressure rise occurs.

C. Figure 1 shows a typical cycle obtained under the above condition. The first pressure rise is due to the injection of compressed air and gasoline vapor into the chamber. The valve has completely closed and the spark fires at point "A." Initial combustion of the charge is very slow for about 0.01 sec, up to point "B," where the burning reaches explosive velocity and causes a combustion pressure rise to more than 250 psig.

D. The rate of valve opening and closing has now been made fast enough so that with the spark far advanced, no backfires occur, showing that the velocity of the air-fuel mixture through the valve is greater than the rate of flame propagation during the early stages of combustion. The slow initial burning rate is the barrier to obtaining higher chamber pressures, since the compressed charge expands to about half its original pressure during this period. Advancing the spark does not correct this. Multiple ignition, with two or more spark plugs firing in parallel, might give the more rapid initial combustion required. However, these tests will not be conducted as all work on the project has been discontinued as of this date.

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TYPICAL INDICATOR DIAGRAM - CAM ACTUATED GAH

Figure 1